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ELECTRIC CONTACT

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This invention relates to electric contacts.

An object of the invention is to improve the characteristics of electric contact elements containing silver.

Another object of the invention is to provide an improved silver base contact material consisting of silver plus more refractory constituents.

A still further object is to provide a new and improved contact material which can be used under severe electrical conditions without welding.

It is a further object of the invention to provide contacts capable of operating on high frequency at heavy current values without objectionable contact metal transfer.

Other objects of the invention will be apparent from the following description taken in connection with the appended claims.

The present invention comprises a combination of elements, methods of manufacture and the product thereof, brought out and exemplified in the disclosure hereinafter set forth, the scope of the invention being indicated in the appended claims.

While a preferred embodiment of the invention is described herein, it is contemplated that considerable variation may be made in the method of procedure, and the combination of elements without departing from the spirit of the invention.

The present invention comprises an improvement in silver refractory metal contact elements and especially in contact elements formed of at least 25% silver.

For certain contact uses silver is mixed with refractory materials such as tungsten, molybdenum and their carbides. These materials are prepared by either mixing the powdered ingredients together in the desired proportions, pressing the mixtures and hot or cold working the pressed material into suitable forms or by pressing and sintering the refractory constituent or constituents with or without part of the silver and then impregnating the sintered body with molten silver.

It has been found that combinations of silver with members of the group mentioned above, especially when prepared by treating at temperatures below the melting point of silver, have a definite tendency toward a preponderance of metal transfer from the anode to the cathode.

We have found that the addition of the third element, such as silicon to compositions of silver-tungsten or silver-molybdenum or silver-tungsten molybdenum, or silver and the refractory carbides, decreases noticeably this transfer tendency.

The mixture should be substantially free of copper, of which it should not contain more than 1%. This is very essential. Our experiments have shown that with a copper content of more than 1% and particularly with copper contents in the neighborhood of 5%, the metal composition shows totally different properties, from the material substantially free of copper, rendering it unsuitable for most electric contact uses.

As is generally known, copper will oxidize very readily, and copper oxide has a high contact resistance. Furthermore, in the silver system, containing copper, the solid solubility decreases with temperature and below 300 degrees C., less than 1% of copper is soluble. The remainder of the copper is contained in the form of free copper particles, and these copper particles have a tendency to preferential oxidation.

Silver and silicon form a eutectic combination containing 4.5% silicon. This eutectic has a melting point of 830 degrees C. In the binary system of silver and silicon, as contemplated in the present invention, there are no intermetallic compounds formed.

It also has been found that it is possible to incorporate a certain amount of manganese, which also improves the alloys, reducing the transfer tendency.

The materials of the present invention may be prepared by any of the known powder metallurgical processes, for example, by mixing, pressing and hot or cold working according to the method previously described. Silicon will form an alloy with the refractory metals, covered by the present invention, such as tungsten and molybdenum. It will also form an alloy, as pointed out above, with silver. By applying proper diffusion methods, therefore, an alloy can be formed of silicon, with both of the major ingredients of the composition covered by the present invention. This provides a material which is very strong mechanically and will resist mechanical abrasion. At the same time, the particles are bound together firmly, so that the electrical erosion is greatly reduced and the material will not evaporate under arcing conditions, and cause what is generally known as transfer.

The material of the present invention may also be prepared by a so-called impregnating method. That is, the refractory metals may be pressed and sintered and then impregnated with an alloy

that does not consist of pure silver, but of an alloy of silver and silicon. The silicon content of such a silver alloy may vary from about .1% to 15%.

If such an impregnation process is used, we have found that pieces of larger cross section can be impregnated and the resulting material will be completely uniform and strong and will have a greater resistance to material transfer. The methods described in the prior art will not result in a product of uniform composition and density throughout the entire cross section. The temperatures which might be used in the impregnation process are in the neighborhood of 1100 to 1400 degrees C.

If the alloys are produced by a straight pressing and sintering process, then temperatures below the melting point of silver or the silver-silicon alloy, will be employed. In such cases, however, it is advisable to employ longer periods of sintering, in order to obtain as complete diffusion as possible.

The contacts contemplated by the present invention may be composed of the ingredients in approximately the following proportions:

	Per cent
Silicon	.05 to 5
Tungsten, molybdenum and their carbides	10 to 75
Silver	Balance

Following are examples of specific compositions contemplated by the invention:

		Per cent
a.	Silicon	.05
	Tungsten	71.7
	Iron	.25
	Silver	28.0
b.	Silicon	.1
	Tungsten carbide	65.0
	Silver	34.9
c.	Silicon	.25
	Tungsten carbide	49.75
	Silver	50.0
d.	Silicon	.25
	Molybdenum carbide	49.75
	Silver	50.0
e.	Silicon	.3
	Molybdenum carbide	34.7
	Silver	65.0
f.	Silicon	.5
	Molybdenum	24.0
	Silver	75.5
g.	Silicon	.25
	Tungsten carbide	30.0
	Molybdenum carbide	30.0
	Silver	39.75

In the cases where the higher percentages of refractory materials are used, the compositions can preferably be made by an impregnation method. Where lower percentages of refractory materials are used, it may be preferable to produce the compositions by pressing and sintering or pressing and working.

On applications for standard relay equipment operating on a direct current at relative high frequency, it has been found that the use of alloys of the type covered by the present combinations will increase the critical current value between 80 and 100% over other commercial silver refractory combinations at present available.

The critical current value indicates the amperage at which sticking occurs.

The combination of the present application gives transfer values of .005" in comparison to .062" with a silicon free material on equivalent tests.

What is claimed is:

1. An electric contact formed of a composition of .05 to 5% silicon, 10 to 75% refractory material selected from the group consisting of tungsten, molybdenum and their carbides, and the balance substantially all silver, said refractory material being in a finely divided state intermixed and bonded with an alloy comprising said silver and silicon, said composition being substantially free of copper.

2. An electric contact formed of a composition of .05 to 5% silicon, 10 to 75% refractory material selected from the group consisting of tungsten, molybdenum and their carbides, and the balance silver.

3. An electric contact formed of a composition of .05 to 5% silicon, 50 to 75% refractory material selected from the group consisting of tungsten, molybdenum and their carbides, and the balance silver.

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